TECHNICAL PRODUCT MANUAL

Three-Phase Energy Meter

Installation | Operation | Communication

ENERGY METERING | DIN-RAIL MOUNTING | 4G

SEM4MT-4G · 7P three-phase, direct connection, 4G · Multi-tariff optional · VER 1.2

Technical reference for installation, configuration and communication.

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1. Overview

The SEM4MT-4G is an IoT three-phase DIN rail energy meter for low- and medium-voltage systems (0.4 kV directly, or 6–35 kV through transformers). It combines measurement, metering and control: three-phase AC measurement and calculation, energy accumulation, RS485 communication, and 4G wireless data transmission to a remote platform. Multi-tariff metering, maximum demand and one relay alarm output are available as options.

The meter is intended for power, telecommunications, railway, transport, environmental protection, petrochemical and steel installations, where the consumption of AC equipment has to be monitored.

Main functions

- Measurement of three-phase voltage and current, phase angle, total and per-phase active and reactive power, power factor, frequency, and active and reactive energy.
- Four multi-tariff profiles (optional).
- Maximum demand metering (optional).
- RS485 interface with Modbus-RTU protocol; DL/T645-2007 optional.
- One relay output (optional).
- 4G wireless transmission.

Key features

The measuring channels are sampled and calculated independently, so the three phases are symmetrical in use and any of the usual wiring arrangements can be connected.

Interference immunity is designed for a power-system environment: electrostatic discharge, fast transient bursts and high-voltage impulse to level 4, surge to level 3; front panel IP54, housing IP20.

The housing fits a standard 35 mm DIN rail; the case is designed for quick installation and wiring.

The segment LCD shows several quantities at once, and the four keys make reading data and setting parameters straightforward.

2. Specifications

Table 2-1 lists the performance data. Values marked optional depend on the configuration ordered.

Table 2-1 Performance parameters

Item	Specification
Distribution network	Three-phase three-wire, three-phase four-wire
Voltage – rated	AC 100 V, 220 V, 380 V
Voltage – overload	1.2 × continuous, 2 × for 10 s
Voltage – burden	< 0.1 VA per phase
Voltage – impedance	> 1 MΩ
Voltage – accuracy	Class 0.5, true RMS measurement
Current – rated	Direct connection 10(40) A, 20(80) A
Current – overload	1.2 × continuous, 10 × for 1 s
Current – burden	< 0.4 VA per phase
Current – impedance	< 10 mΩ
Current – accuracy	Class 0.5, true RMS measurement
Frequency	40–65 Hz, accuracy ±0.01 Hz
Power	Three-phase active class 1, reactive class 2
Energy	Four-quadrant metering; active class 1, reactive class 2
Multi-tariff *(optional)*	4 profiles, 4 tariffs, 12 time periods
Maximum demand *(optional)*	Monthly maximum demand for the last three months
Display	Segment LCD, programmable
Auxiliary supply	Three-phase voltage input, AC 85–456 V
Supply burden	≤ 4 VA
Digital interface	RS-485, Modbus-RTU (DL/T645-2007 optional)
Network interface	4G
Pulse output	1 active energy pulse output
Relay output *(optional)*	1 output, 5 A / 250 V AC, 5 A / 30 V DC
Operating conditions	–10 to +55 °C, altitude ≤ 2000 m, 93 % RH, non-condensing, no corrosive gas
Storage conditions	–30 to +70 °C
Dielectric strength	Input to supply > 2 kV; input to output > 2 kV; supply to output > 2 kV
Insulation	Input, output and supply to case > 5 MΩ

3. Installation and Wiring

Read this chapter before installing or wiring the meter.

3.1 Dimensions and mounting

The meter measures 126 × 100 × 80.8 mm and mounts on a 35 mm DIN rail. Terminals are accessible from the front.

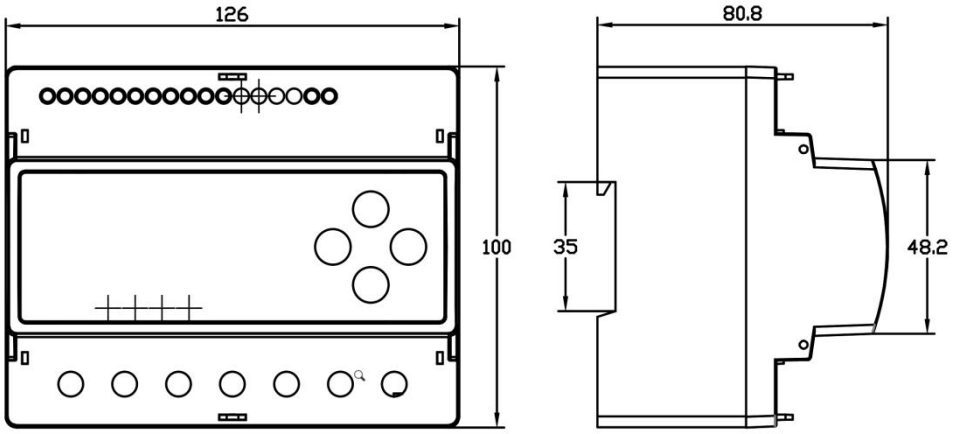

Fig. 3-1 Mechanical dimensions, front and side view (mm)

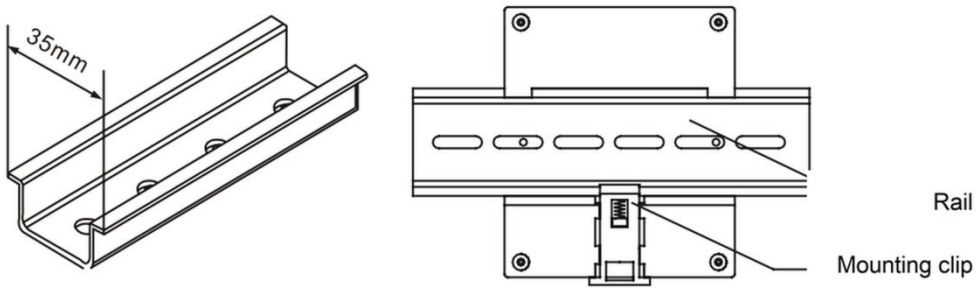

Fig. 3-2 DIN rail mounting

3.2 Terminals and wiring

The product is available in a direct-connection and a transformer (CT) version; the version must be stated on the order. The voltage and current inputs are on the main terminal block; terminals 12 to 17 carry the communication and pulse outputs. The wiring of the direct-connection version is shown below.

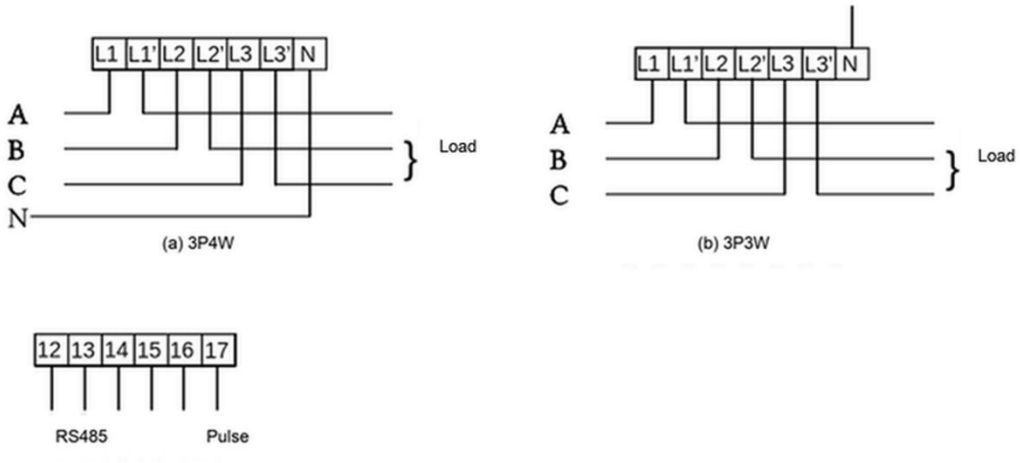

Fig. 3-3 Direct-connection wiring: (a) 3P4W, (b) 3P3W

The wiring diagram on the delivered meter prevails.

3.3 Wiring precautions

- Select the conductor cross-section according to the current range and the actual load.
- Use shielded twisted pair for the communication cable.
- Do not reverse RS485+ and RS485−.
- For a linear bus, fit 100–120 Ω terminating resistors across RS485+ and RS485− at both ends of the cable.
- At 9600 bit/s the cable length must not exceed 1200 m.
- Keep communication cables away from power cables; a T-shaped bus is preferred to a star topology.

4. Display, Keys and Indicators

The front panel carries a segment LCD, four keys and four indicator LEDs.

4.1 Display and page sequence

After 30 s without a key press the display cycles automatically between four-quadrant energy, tariff energy, maximum demand and time; each page is shown for 4 s by default and the interval can be changed in the menu (DISP). Pressing a key enters manual paging, in which the measured quantities below can be read as well.

Page	Content	Unit	Remarks
1	Total forward active energy	kWh	
2	Total reverse active energy	kWh	
3	Total forward reactive energy	kvarh	
4	Total reverse reactive energy	kvarh	
5	Tariff energy	kWh	Confirm key switches total / current month / previous month / two months ago, and T1–T4
6	Maximum demand	kW / kvar / kVA	Confirm key switches active, reactive, apparent and the month; 15-minute sliding demand by default
7	Date, time and tariff mode	—	Current tariff shown as sharp, peak, flat or valley
8 …	Phase voltage, current, power, power factor, frequency	V / A / kW / — / Hz	Available in manual paging

4.2 Indicator LEDs

LED	Lit when
Reverse	Any phase has reverse active power

LED	Lit when
Loss of voltage	Any phase voltage is below 5 % of the rated value
Pulse	Active energy pulse
Signal	Flashes faster as the signal gets stronger; steady in configuration mode

4.3 Keys

- Up key – short press: page forward through the measured values.
- Down key – short press: page backward.
- Menu key – short press: open the programming menu, and step back out level by level.
- Enter key – short press: confirm and store the value shown.

5. Menu and Settings

Press the menu key in the measuring display; PASS appears. Enter the user password (0001 by default) and confirm to enter the programming menu. The menu has three main branches – system (SYS), input (–In–) and communication (bUS) – plus the relay output (do-1), time, reading day and tariff settings.

5.1 Menu structure

Level 1	Level 2	Setting range	Description
SYS	CodE	0001 (default)	User-level password
	DISP	0004 (default)	Page time in seconds
	CLrd	—	Clear maximum demand
	CLRE	—	Clear energy registers
–In–	Lin.e	3P4L, 3P3L	Input network / wiring mode
	U.SCL	100 V, 220 V	Voltage range of the input signal
	I.SCL	20 A, 10 A, 5 A, 1.5 A	Current range of the input signal
	r.PT	1–9999 (default 0001)	Voltage ratio
	r.CT	1–9999 (default 0001)	Current ratio
bUS	Addr	1–247 (default 0001)	Communication address
	bAUd	2400, 4800, 9600	Baud rate (default 4800)
	dAtA	n.8.1, o.8.1, e.8.1	Data format (default n.8.1)
do-1	TYPE	r.n, ALr, OFF (default ALr)	Relay mode: remote, alarm or off
	DELY	0010 (default)	0000 = level output; other = delay / pulse width
	PArA	UA-H … Fr-L	Parameter monitored, -H high limit, -L low limit
	VALU	5500 (default)	Alarm threshold, in secondary values

Level 1	Level 2	Setting range	Description
	HYS	0050 (default)	Hysteresis
TIME	YEAR … SEC	00–99 / 1–12 / 1–31 …	Clock: year, month, weekday, date, hour, minute, second
E.dAy	E.dAy	0101 (default)	Reading day and hour
E.mon	Mon / E.SE1	1–12 / profile 1–4	Month and tariff profile assigned to it
E.SE1–4	S.EG1 … S.EGC	0000–2359 and TInE / PEAK / FLAt / LOW	Up to 12 periods per profile, each with a start time and a tariff

5.2 Time periods and tariffs

Each tariff profile divides the day into up to twelve periods, and each period carries one of four tariffs: TInE (sharp), PEAK, FLAt and LOW (valley). A period starts at the time written as hhmm; the last period ends where the first one starts. Leave the unused segments at 0000.

Segment	Start (hhmm)	Tariff	Meaning
SEG.1	0000	LOW	Midnight
SEG.2	0600	PEAK	06:00
SEG.3	2200	LOW	22:00
SEG.4	0000	—	End of the setting

With this example the day is metered in three periods: valley from 00:00 to 06:00, peak from 06:00 to 22:00, and valley again from 22:00 to midnight.

5.3 Setting a ratio

Enter the ratio of the voltage or current transformer in r.PT and r.CT. For a meter ordered with a voltage input of AC 20 kV / 100 V and a current input of AC 100 A / 5 A, used with a 10 kV / 100 V voltage transformer and a 200 A / 5 A current transformer:

1. Press the menu key, enter 0001 and confirm. Select –In– and confirm.
2. Select r.PT and enter 100 (10 kV / 100 V = 100), then confirm.
3. Select r.CT and enter 40 (200 A / 5 A = 40), then confirm.
4. Press the menu key repeatedly until SAVE appears, then confirm to store. Leaving without SAVE discards the change.

5.4 Display prompts

Prompt	Meaning
PASS	Password entry; enter 0001 and confirm
ErrO	The password or the value entered is not accepted
SUrE	Confirmation requested before a change is applied
SAVE	Store the changes and leave the programming menu

6. Measurement and Formulas

All quantities are calculated from the sampled values with the discrete formulas below, where N is the number of samples in one AC cycle and u , i are the samples of voltage and current.

Formula	Quantity
$U = \sqrt{(1/N \cdot \Sigma u^2)}$	True RMS voltage
$I = \sqrt{(1/N \cdot \Sigma i^2)}$	True RMS current
$P = (1/N) \cdot \Sigma (i_a u_a + i^b u^b + i^c u^c)$	Total active power, cycle average
$Ps = U \cdot I$	Apparent power, per phase
$\cos \theta = Pp / Ps$	Power factor
$Pq = \sqrt{(Ps^2 - Pp^2)}$	Reactive power
$W = \int P \, dt$	Energy

When P > 0 the accumulated active energy is energy taken from the network; when P < 0 it is energy delivered. When Pq > 0 the reactive energy is inductive; when Pq < 0 it is capacitive. The four quadrants are shown below.

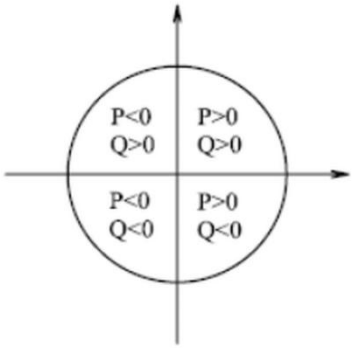

Fig. 6-1 Four-quadrant definition of active and reactive energy

7. Pulse and Relay Output

7.1 Pulse output

The meter provides one active-energy pulse output through an open-collector opto-coupler, used to check accuracy and to totalize energy in a remote terminal, PLC or digital input module. Electrical characteristics: open-collector voltage VCC ≤ 48 V, current Iz ≤ 50 mA. The pulse is high for about 80 ms.

Current (A)	Pulse constant (imp/kWh)	Connection
20(80)	400	Direct connection
10(40)	800	Direct connection
5(20)	1600	CT connection
1.5(6)	6400	CT connection

For a constant of 6400 imp/kWh, one pulse corresponds to 1/6400 kWh. With PT and CT connected, N pulses on the secondary side correspond to N/6400 kWh × PT ratio × CT ratio on the primary side.

7.2 Relay alarm

The relay can work in three modes: r.n (remote), ALr (alarm) and OFF. In alarm mode the monitored parameter is chosen with PArA: the suffix -H means a high limit and -L a low limit; I3 and U3 mean that any of the three phases triggers the alarm. DELY is the response delay, from 0001 (100 ms) to 9999 (999.9 s). VALU is the threshold in secondary values; HYS is the hysteresis, so that the relay only drops out after the quantity has returned past the limit by that amount.

Parameter	Unit of VALU
Voltage	0.1 V
Current	0.01 A
Active power	0.01 kW
Reactive power	0.01 kvar
Apparent power	0.01 kVA
Power factor	0.001
Frequency	0.01 Hz

Example: to operate the relay when IA exceeds 35.00 A and release it below 34.90 A with a 1 s delay, set ModE = ALr, PArA = IA-H, vALU = 3500, HyS = 0010 and dELy = 0010.

7.3 Remote control

In remote mode the output follows commands received over the bus. Function code 05 is used; register 0x0001 addresses relay 1, FF00 closes and 0000 opens. The slave returns the request unchanged. DELY = 0000 gives a level output; any other value gives a pulse of that width.

Frame	Content (hex)	Meaning
Request	01 05 00 01 FF 00 DD FA	Close relay 1 of slave 01
Response	01 05 00 01 FF 00 DD FA	Echo of the request

8. Communication

8.1 RS485 interface and 4G uplink

The meter provides an asynchronous half-duplex RS485 interface using the Modbus-RTU protocol. Up to 32 meters can be connected to one bus, each with its own address. Use shielded twisted pair of at least 0.5 mm², keep the cable away from power cables, and prefer a T-shaped bus to a star topology.

Measured values, energy registers and status can also be uploaded over the built-in 4G

module. The signal LED flashes faster as the signal becomes stronger, and is steady in configuration mode.

8.2 MODBUS frames

Frames follow the RTU structure: address, function code, data and CRC16. Only function codes 03/04 (read), 05 (relay), 06 and 10 (write) are supported.

Frame	Content (hex)	Meaning
Request	0C 03 00 0C 00 06 44 D2	Read 6 registers from 0x000C of slave 0x0C
Response	0C 03 0C … CRC	Data length 0x0C bytes, then the values, then CRC16
Error	No response	Slave stays silent when the request is invalid

Primary values are IEEE 754 single-precision floats. After reading, the high and low words of each value are swapped to obtain the stored float: a voltage read as 19H 9AH 43H 5CH becomes 435C199A, which corresponds to 220.100006 and is displayed as U = 220.1.

8.3 MODBUS register table

Addresses are hexadecimal; “words” is the number of 16-bit registers occupied by one value. The secondary parameter block is not valid on the direct-connection version.

Address	Item	Type	Words	Description
Primary parameters — floats, 2 words each				
0x0000	Ua	float	2	Phase voltage A, V
0x0002	Ub	float	2	Phase voltage B, V
0x0004	Uc	float	2	Phase voltage C, V
0x0006	Uab	float	2	Line voltage AB, V
0x0008	Ubc	float	2	Line voltage BC, V
0x000A	Uca	float	2	Line voltage CA, V
0x000C	Ia	float	2	Phase current A, A
0x000E	Ib	float	2	Phase current B, A
0x0010	Ic	float	2	Phase current C, A
0x0012	Pa	float	2	Active power, phase A, kW
0x0014	Pb	float	2	Active power, phase B, kW
0x0016	Pc	float	2	Active power, phase C, kW
0x0018	PΣ	float	2	Total active power, kW
0x001A	Qa	float	2	Reactive power, phase A, kvar
0x001C	Qb	float	2	Reactive power, phase B, kvar
0x001E	Qc	float	2	Reactive power, phase C, kvar
0x0020	QΣ	float	2	Total reactive power, kvar
0x0022	Sa	float	2	Apparent power, phase A, kVA
0x0024	Sb	float	2	Apparent power, phase B, kVA

Address	Item	Type	Words	Description
0x0026	Sc	float	2	Apparent power, phase C, kVA
0x0028	SΣ	float	2	Total apparent power, kVA
0x002A	PFa	float	2	Power factor, phase A, 0–1.000
0x002C	PFb	float	2	Power factor, phase B
0x002E	PFc	float	2	Power factor, phase C
0x0030	PFΣ	float	2	Total power factor
0x0032	FR	float	2	Frequency, 0.01 Hz
0x0034	Ep+	float	2	Forward active energy, kWh
0x0036	Ep–	float	2	Reverse active energy, kWh
0x0038	Eq+	float	2	Inductive reactive energy, kvarh
0x003A	Eq–	float	2	Capacitive reactive energy, kvarh
Secondary parameters — integers (not valid on direct connection)				
0x0100	Ua	int	1	Ua, 0.1 V
0x0101	Ub	int	1	Ub, 0.1 V
0x0102	Uc	int	1	Uc, 0.1 V
0x0103	Uab	int	1	Uab, 0.1 V
0x0104	Ubc	int	1	Ubc, 0.1 V
0x0105	Uca	int	1	Uca, 0.1 V
0x0106	Ia	int	1	Ia, 0.001 A
0x0107	Ib	int	1	Ib, 0.001 A
0x0108	Ic	int	1	Ic, 0.001 A
0x0109	Pa	int	1	Pa, W
0x010A	Pb	int	1	Pb, W
0x010B	Pc	int	1	Pc, W
0x010C	PΣ	int	1	PΣ, W
0x010D	Qa	int	1	Qa, var
0x010E	Qb	int	1	Qb, var
0x010F	Qc	int	1	Qc, var
0x0110	QΣ	int	1	QΣ, var
0x0111	Sa	int	1	Sa, VA
0x0112	Sb	int	1	Sb, VA
0x0113	Sc	int	1	Sc, VA
0x0114	SΣ	int	1	SΣ, VA
0x0115	PFa	int	1	PFa, 0.001
0x0116	PFb	int	1	PFb, 0.001
0x0117	PFc	int	1	PFc, 0.001
0x0118	PFΣ	int	1	PFΣ, 0.001
0x0119	FR	int	1	FR, 0.01 Hz
0x011A	Ep+	int	2	Forward active energy, Wh
0x011C	Ep–	int	2	Reverse active energy, Wh
0x011E	Eq+	int	2	Inductive reactive energy, varh
0x0120	Eq–	int	2	Capacitive reactive energy, varh

Address	Item	Type	Words	Description
Meter status and clock				
0x0200	DO	int	1	Relay output state, bits 0–1
0x020A	TIME.year	int	1	Year
0x020B	TIME.month	int	1	Month
0x020C	TIME.date	int	1	Date
0x020D	TIME.hour	int	1	Hour
0x020E	TIME.minute	int	1	Minute
0x020F	TIME.second	int	1	Second
0x0210	TIME.day	int	1	Weekday
Maximum demand				
0x0300	Pde	float	2	Present active demand
0x0302	Qde	float	2	Present reactive demand
0x0304	Sde	float	2	Present apparent demand
0x0306	Pdmax	float	2	Maximum active demand, current month
0x0308	Qdmax	float	2	Maximum reactive demand, current month
0x030A	Sdmax	float	2	Maximum apparent demand, current month
0x030C	—	float	2	Maximum active demand, previous month
0x030E	—	float	2	Maximum reactive demand, previous month
0x0310	—	float	2	Maximum apparent demand, previous month
0x0312	—	float	2	Maximum active demand, two months ago
0x0314	—	float	2	Maximum reactive demand, two months ago
0x0316	—	float	2	Maximum apparent demand, two months ago
Multi-tariff energy				
0x0400	Cumulative_tol	long	2	Total energy
0x0402	Cumulative_T1	long	2	Total energy, tariff T1 (sharp)
0x0404	Cumulative_T2	long	2	Total energy, tariff T2 (peak)
0x0406	Cumulative_T3	long	2	Total energy, tariff T3 (flat)
0x0408	Cumulative_T4	long	2	Total energy, tariff T4 (valley)
0x040A	Current_tol	long	2	Total energy, current month
0x040C	Current_T1	long	2	Energy, current month, T1
0x040E	Current_T2	long	2	Energy, current month, T2
0x0410	Current_T3	long	2	Energy, current month, T3
0x0412	Current_T4	long	2	Energy, current month, T4
0x0414	Prior_tol	long	2	Total energy, previous month
0x0416	Prior_T1	long	2	Energy, previous month, T1
0x0418	Prior_T2	long	2	Energy, previous month, T2
0x041A	Prior_T3	long	2	Energy, previous month, T3
0x041C	Prior_T4	long	2	Energy, previous month, T4
0x041E	—	long	2	Total energy, two months ago
0x0420	—	long	2	Energy, two months ago, T1
0x0422	—	long	2	Energy, two months ago, T2

Address	Item	Type	Words	Description
0x0424	—	long	2	Energy, two months ago, T3
0x0426	—	long	2	Energy, two months ago, T4